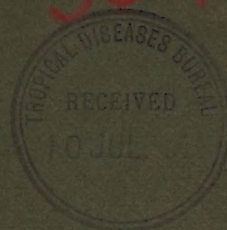


WELLCOME INSTITUTE LIBRARY	
Coll.	welTROmec
Cell	Pam
No.	WC 530
	1912.
	5454

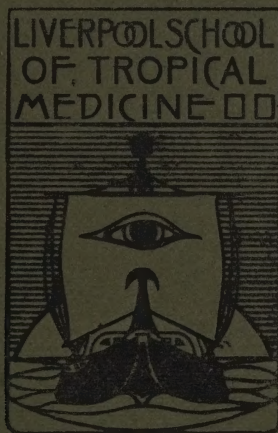
Yellow Fever Prophylaxis



BY

HARALD SEIDELIN

REPRINTED FROM THE
YELLOW FEVER BUREAU BULLETIN
VOL. I, No. 10, FEBRUARY, 1912



PUBLISHED BY
THE UNIVERSITY PRESS OF LIVERPOOL, 57 ASHTON STREET, LIVERPOOL



22200128285

YELLOW FEVER PROPHYLAXIS

BY HARALD SEIDELIN.

As a consequence of the knowledge of yellow fever as an insect-borne disease, hard and fast rules were laid down for its prophylaxis, and it appeared that this question had been settled for all time. Many good results obtained have justified the application of these rules, but the failure, in some cases, of exterminating yellow fever by similar measures, makes it necessary to open the discussion anew. This failure cannot have been due, so much seems evident, to any error in the fundamental rules; the reason will have to be sought, either in a deficiency in their application, or there may possibly exist errors in details of the theory as it stands. If the latter possibility be admitted, the details in question must be such as have been of no importance in the cases in which satisfactory results have been obtained, whilst in some instances they have been of sufficient importance to make the measures taken, more or less useless.

Immediately after the doctrine of mosquito transmission had been recognized as, with great probability, the correct one by the United States Health Authorities in Cuba, the campaign against yellow fever was organized on this new basis, in Habana, 1901, and soon resulted in the extermination of the disease. Subsequently similar campaigns were started in Panama, Colon, Rio de Janeiro, and other cities, likewise with good results, which in the case of Rio were particularly striking, since sanitary reforms, which had shortly before been carried out according to ordinary rules of hygiene, had remained entirely without influence on the yellow fever situation. The measures which were taken in these campaigns, and which have since then continued to form the basis for the whole prophylaxis against yellow fever, can be divided into the following three groups:—

1. Mosquito destruction.
2. Protection of yellow fever patients against mosquito bites.
3. Protection of non-immune individuals against mosquito bites.

The last mentioned measure has probably never been carried out satisfactorily except in individual cases, and must, as a matter of fact, always remain of very limited utility when we have to do with a house mosquito like *Stegomyia fasciata*, which in infested towns is met with almost everywhere, and in large numbers. Mosquito-proof houses are of a relative value, even if it be true that infected mosquitos bite at night-time only. They seem never to have played a great rôle in the anti-yellow fever campaigns, and the only proof on a large scale of the importance of the protection of non-immunes still remains in the oft-quoted example that well-to-do foreigners, having their work in Rio, but remaining during the night in the *Stegomyia*-free Petropolis, escaped yellow fever, even when severe outbreaks prevailed. This single instance is not in strict accordance with the experimental observations on the biology of *Stegomyia fasciata*, since the foreigners in Rio are said to leave for Petropolis several hours later in the afternoon than infected females, according to Marchoux and Simond, begin to bite.

For people living in a city, life will always be extremely difficult and full of inconveniences if they have to protect themselves absolutely against mosquito bites, should it be from dark to morning only. This measure will never be practicable as anything like a thorough protection where a large number of non-immune foreigners belonging to different social classes are present amongst a native population, from which they do not keep entirely apart socially. It will, therefore, only be possible in colonies where a few well educated and well disciplined Europeans are living isolated in an infected country.

A partial isolation is obtained by means of the so-called segregation, i.e., the Europeans live in a separate quarter of a town, as far as possible from the dwelling-houses of the natives. In this case the object is to obviate, not the bites of mosquitos in general, but the bites of infected mosquitos. The latter system has been extensively adopted in British Colonies, in Africa and elsewhere.

In the large majority of cases we shall have to consider the first and second of the measures mentioned. Isolation of yellow fever patients in mosquito-proof rooms naturally suggests itself as the simplest and most rational way of solving the problem. It would certainly be so, could it be carried out in anything like a thorough manner, but it meets with many difficulties, at any rate in endemically infected areas. To be even approximately effective, isolation must take place from the very beginning of the disease, a desideratum which seems very distant, as it is evident from many circumstances, and as is illustrated by the fact that the clinical observations which are found in such large numbers in the literature very seldom date from the first day of the disease, or even from the second. Cases must be isolated before a diagnosis can be made, on the mere suspicion of yellow fever, that is to say, in the case of any elevation of temperature the cause of which is not quite clear. This is carried out, in some places and in a more or less systematic way, when foreigners are concerned, but certainly in no endemic area are all natives with vague febrile symptoms isolated. Recent experiences, however, go far towards demonstrating the truth of the view already expressed by many writers on the subject, that the natives form the most important source of infection. Typical cases have been observed in natives—particulars of an outbreak of this kind will be published later on—and some of these cases have occurred under conditions which make it probable that the individuals attacked had not been exposed, for many years past, to the infection, living in somewhat retired places. This forms the best proof that no race immunity exists, but that the immune natives have acquired their immunity through one or several attacks of the disease. Natives with typical yellow fever constitute already a particular danger, because the diagnosis is generally not made until very late in the disease, if at all, as many physicians are opposed to accepting the diagnosis of yellow fever in natives. A still greater danger, however, exists, from an epidemiological point of view, in the atypical cases in native children and adults.

Such cases are practically never isolated, and there can be little doubt that they are the most frequent of all. Whether natives suffer from yellow fever once only, or repeatedly, cannot be definitely settled so far, but that they all suffer therefrom can be taken for granted, and it is most likely that they undergo repeated attacks. If the latter supposition be the correct one, the conclusion lies very near that they are infected with great frequency even, as they are certainly bitten daily by mosquitos, a large percentage of which must be infected. The yellow fever parasite when introduced into a previously immunized organism may not develop at all, but it appears likely that it may sometimes, or often, develop to a certain extent before being destroyed; in such a case their presence might never make itself known through clinical symptoms, though being sufficient to produce infection in other mosquitos. This is the theory which in the apparently most probable way explains the continuous preserving of the virus in endemically infected areas. If accepted, it must at once be admitted that the isolation of patients with typical yellow fever symptoms cannot be expected to lead to the extermination of the disease in an endemic focus. It may, perhaps, keep from the possibility of propagation some of the most virulent of the parasites, though at present we know almost nothing as to their differences of virulence.

Then comes the question of the duration of isolation. According to the generally accepted doctrine, the blood is infectious during the first three or four days only, in cases of yellow fever. I have endeavoured to show, in several publications, that there is no proof that this is really so. It would be very dangerous to proceed in strict accordance with that rule, but, fortunately, in practice it is seldom followed to the letter. Cases are, as a rule, kept isolated until convalescence is established, and it is to be hoped that we may arrive at the same point as in malaria, that they may be kept isolated until the parasites have disappeared from the blood. Isolation, whether of patients, or of non-immunes, can never be satisfactorily carried out. The corresponding measures should always be taken where *Stegomyia* are

present, but they afford, as a whole, rather unreliable protection.

The only radical measure is mosquito destruction. This measure should be carried out in times of peace, when no yellow fever is present, in all exposed areas, and, with more reason still, where an outbreak already exists, or in countries recognized as endemic foci. The objection is often raised against mosquito destruction that it is impossible. The impossibility has already been disproved in many places, and the logical outcome of many successful anti-mosquito campaigns would seem to be that the complete extermination of mosquitos is always possible, at any rate in cities. It is quite certain that the problem is often an extremely difficult one; the measures to be taken are generally costly and must be continued with a persevering and never-failing energy.

When discussing the particulars of prophylactic measures it will be convenient to consider, separately, places where yellow fever is endemic, and those into which it is or may be introduced occasionally.

In endemic foci *Stegomyia* are probably always abundant. Exact data from all places are not available, but more or less exact statistics have been prepared in some places, and from many others the general impression is reported that *Stegomyia fasciata* is the prevailing or, at any rate, a very common mosquito. It may, of course, not be out of the way to fumigate all houses in which yellow fever cases have occurred, but too much importance should not be given to this measure. All available energy should be directed towards the prevention of mosquitos obtaining breeding places.

This is done by abolishing all collections of water which are not absolutely necessary. Water containers which are retained as indispensable must be looked after in some way or other so that they cannot serve as breeding places. If practicable, and especially in the case of drinking water, they should be protected by means of a well-fitting cover or wire gauze. It would certainly be much better to provide a central, pipe-borne water supply for drinking and other

purposes, and thus make the larger number of water containers superfluous, but this is not always practicable, either on account of the prohibitive cost, or because no proper drinking water is to be found besides rain water.

In water which is retained for ornamental purposes fish stocking should be made obligatory; the presence of a few gold fish or other fish, of which already a large number are known as larvae-eating, will effectually exclude all danger.

In the case of cesspits or other water collections which cannot at once be dispensed with, oiling becomes necessary. For this purpose mixtures of crude and refined petroleum in varying proportions are most extensively used; but any greasy substance, which on floating on the surface of the water forms a continuous layer, will fulfil the object of impeding the larvae from reaching the surface for breathing. The quantity of oil necessary is, according to Boyce, one ounce to the square yard (30 c.cm. to the square metre). A larger amount must be calculated if the water is exposed to the wind than in the case of an absolutely quiet surface, as in the former case the continuous layer will easily be disturbed. The oil will disappear through evaporation after a period, the length of which depends on the exposure to the sun, the prevailing temperatures, and the presence or absence of air currents. It should, therefore, be renewed with sufficient frequency to assure that it will never be absent during a time long enough for the development of the mosquito from egg to imago. For this period a minimum of about twelve days may be calculated; in order to be efficient, oiling should therefore take at least once every ten days. For practical reasons, however, it is generally preferred to proceed with regular intervals of a week.

In addition to its suffocating effect on the larvae, oil will also prevent female mosquitos from depositing their eggs in the water, but this action is of less importance, as the layer is not constantly present.

Beside petroleum, many other substances have been recommended for the purpose of killing larvae in water, particularly a number of the common antiseptics, but so far

none has given satisfactory results. Larvae resist to a surprising degree the action of chemical poisons. I have kept *Stegomyia* larvae living for many hours in a solution of mercury bichloride of 1 to 10,000, and the pupae may persist for days in a solution of the same substance in a concentration of even 1 to 1,000. Potassium permanganate and potassium cyanide likewise have but very slight effect on mosquito larvae. The use of antiseptics would, moreover, in most cases produce even greater inconveniences than those resulting from the use of petroleum. Antiseptic solutions of the high concentrations necessary would constitute a considerable danger to man and animals, and the presence of a poison would not make itself known through a characteristic smell as in the case of petroleum.

In the case of cesspits, these must be provided with an outlet for the putrefactive gases; this must be a high, well-fitting tube (of galvanized iron), and its opening must be screened, for if not, mosquitos will find their way through the tube to the water, though its height be many metres to the water.

Mosquito larvae do not thrive in water which is in constant movement. Oiling is therefore superfluous, as it would be useless in the case of running water, but, on the other hand, it should not be taken for granted too readily that a certain water container may be left unprotected because the water is frequently moved. Thus, in Mérida, all wells which are provided with a pump must be kept properly covered, whilst no precautions are obligatory if the water is extracted by means of a bucket. Larvae, however, have repeatedly been found in wells belonging to the latter class, and the matter is at present being reconsidered by the Health Authorities. It would appear that each particular case will have to be considered separately, on its own merits.

That a certain water container is said to be emptied daily does not obviate the necessity of precautions, as it often happens that a few drops of water are left in the bottom of the container each time it is emptied, which will be sufficient for the larvae to live in until it is filled again.

It is well known, but can not be too often repeated, that empty tin cans, bottles and jars which are thrown away carelessly constitute one of the greatest dangers with regard to *Stegomyia* breeding. Any, even the smallest, quantity of water may prove a breeding place for *Stegomyia fasciata*, and all such casual water containers should be destroyed or removed to a place where they can do no harm.

The presence of larvae in the holy water in churches, which has been mentioned previously in the Bulletin (I, 1, p. 7), has also been observed repeatedly in Yucatán.

All these precautions could be carried out easily and with comparatively small expense in each case, if all house-owners would look after the sanitary conditions of their premises. This might be made obligatory, just in the same way that it is incumbent on the owner of a house to maintain a proper sewerage system; but in order to produce satisfactory results, health ordinances to that effect would make a careful inspection necessary to make sure that the regulations were complied with. The inspection would have to be frequent, with intervals not longer than ten days, thus making it impossible for eggs to develop into imagines in the maximum of time during which an infringement of the rules might persist. Better results, however, will often be obtained if the health authorities directly take charge of the situation and carry out the oiling process and all other precautions. A special tax for this purpose would probably encounter but few objections, when house-owners at the same time would find themselves exempt from all responsibility, and nevertheless get rid of the mosquito nuisance.

It has been said already that it will always be useful to isolate yellow fever cases, though one may be convinced that this measure will not suffice to stamp out the disease in an endemic area. Evidently isolation is more indicated still, when a place is in the very process of losing its character of endemic centre on account of the gradual disappearance of mosquitos. Isolation should take place as soon as the possibility of yellow fever has been suggested by the development of a febrile state which cannot with certainty be

otherwise explained in a susceptible individual, keeping in mind what has been said about susceptibility in natives. A patient may be isolated either in a specially constructed hospital, or in his own house if he can afford the expense. In the latter case it will be advantageous to screen not only the sick-room, but also the adjoining room and, if possible, bath-room, watercloset and scullery. It has been pointed out in an earlier paper that the nurse is often herself a non-immune, and should not, if by any means avoidable, be exposed to the bites of possibly infected mosquitos in the patient's house. It is, therefore, important that it should be made possible to carry out the nursing without the necessity of the nurse leaving the screened compartment.

Disinfection, i.e., fumigation with the object of killing all mosquitos, should be done as quickly as possible and as thoroughly as convenient. Besides the patient's own house, at least the directly adjoining houses must be fumigated. Whether the entire block of houses should be included depends on circumstances, and especially on the question whether it can be done without slackening the energy with which the larvae destruction measures are conducted; the latter constitute, always dealing with endemic areas, by far the most important part of the campaign, and should never be neglected, not even for a few days.

If a patient is taken to the hospital, disinfection should take place as soon as the diagnosis has been made. If, on the contrary, he remains at home, disinfection, at any rate of the sick-room cannot, as a rule, take place until the illness is over. Whenever possible, namely when the sick-room or screened compartment lies sufficiently isolated, the remaining parts of the house, as well as the adjoining houses, ought to be fumigated at once, in which case pyrethrum should be used instead of sulphur. Better still, the isolation compartment may be put in order and fumigated, while the patient is kept under a mosquito curtain in another room, and then be re-occupied after previous ventilation. The intervening hours are occupied with preparation of the house, and fumigation can then be proceeded with, when the patient has been

isolated. When the disease has terminated, the screened compartment must be fumigated, if not done to begin with, or in case mosquitos have been observed inside the screened doors.

The screening is best executed by carefully nailing wire gauze over the frames of all windows and doors which are generally left open to facilitate ventilation. One entrance only is left to be used and this one is provided with double doors, both doors and the frame limiting the intervening space being protected with wire gauze. All remaining openings in wooden frames, etc., must, by a very careful inspection, be found out and closed by means of strips of paper, or preferably cloth, which are stuck on from the interior of the room in order to make it impossible for mosquitos to hide away in fissures and thus escape fumigation.

When in use, great care must continually be taken not to open both doors at the same time; the doors are often provided with mechanical appliances with the object of making it impossible to open the one unless the other is closed, but they are often deficient in construction or out of order.

Until the full effect of the mosquito-destroying measures has been obtained, segregation and isolation in mosquito-proof houses will have to be used by foreigners as a provisional means of protection. Details of these measures will be discussed later on.

Exposed places. A certain place must be considered liable to be infected with yellow fever if *Stegomyia* are present, and if it holds commercial relations with yellow fever places or possesses easy means of traffic with such.

In exposed places the only rational measure of protection, which ought to be taken always, is *Stegomyia* destruction, or rather, complete *Stegomyia* extermination. When this has been accomplished, all danger of large epidemic outbreaks will have disappeared; there is only the possibility that some imported infected mosquitos might give rise to a few cases, but the infection would not spread supposing the

anti-mosquito measures were carried on continuously. Even the occurrence of a few isolated cases ought to be avoided, and it is therefore necessary to take good care that no infected *Stegomyia* are imported. To be quite sure, no mosquitos, *Stegomyia* or others, infected or non-infected, should be allowed to be introduced. This is the only precaution necessary, as there is no danger whatever in a *Stegomyia*-free place, even if cases of yellow fever gain access without being diagnosed.

If, on the other hand, *Stegomyia* are present, strict quarantine measures both against yellow fever cases and against mosquitos cannot be dispensed with.

Anti-mosquito quarantine consists in careful fumigation of all ships arriving from ports infected with, or suspected of being infected with yellow fever. Under existing international sanitary conventions it may not be feasible to extend this measure to apply to ships arriving from ports from which no cases of yellow fever have been reported for a considerable length of time, even though *Stegomyia* are known to be abundant.

If a ship is unprotected, all its parts should be fumigated unless it carries a certificate that it has remained moored, during the whole duration of its stay at an infected port, at a safe distance from the shore, i.e., at a distance of about 200 metres in the case of an open port, whilst in closed ports and rivers this distance would probably not be sufficient. The certificate should guarantee also that mosquito-free lighters were used in loading and unloading.

In the case of ships provided with a certificate of this kind, or in that of screened ships, no fumigation ought to be obligatory, but might be made dependent on the result of a careful inspection. Holds which have been opened whilst the ship was in dock or near the shore should be fumigated in any case, and the fumigation must necessarily take place before unloading.

The technique of fumigation will be discussed in the section on epidemic outbreaks.

With regard to passengers from infected ports, it is a

somewhat debated question whether quarantine, in the strict sense of the word, should be preserved or not. There is little doubt that the safest plan would be to keep passengers isolated in mosquito-proof houses in a separate quarantine station, during the whole time which may be considered the maximum period of incubation. This is probably not done in any place. In Habana a six days' quarantine is established, which corresponds to the ordinary length of the incubation period, but it appears that occasionally a period of even thirteen days has been observed; thus, six days cannot be expected to give absolute security.

Considering this, there is much to be said in favour of adopting a different system, namely that of 'surveillance,' i.e., careful observation of the state of health of all passengers from yellow fever ports, during a certain period after their arrival, as it is practised in European countries, for instance in the case of cholera. *When dealing with yellow fever, the problem would be less difficult, the number of passengers being, as a rule, much less.

On arrival, passengers would have to pass an initial examination, state their point of destination, and sign a declaration to the effect that they will report themselves to the local health officer twice daily for two weeks. In the case of any elevation of temperature or other suspicious signs they would be isolated immediately, and proper precautions would be taken. Passengers arriving in mosquito-proof ships might have the number of days since they left an infected port discounted from the total of fourteen.

As an additional precaution, inspection of passengers might take place at the port of departure, but this measure would be of no importance in the case of mosquito-proof ships.

In this way much time and a large amount of expense might be saved, and travelling would suffer but slight disturbance, in fact, insignificant in comparison with a quarantine on the ordinary lines. It is, however, difficult to be certain that the same degree of security would be obtained as that which practice has shown that a strict

quarantine is capable of giving. The only material for comparison which we possess is that supplied by the experience in late years in several countries, especially Germany, which has protected itself by observation measures against importation of cholera from its neighbour, Russia. These experiences certainly are strong arguments in favour of observation. Another argument of some importance is that no distinction would be necessary between immunes and non-immunes, if the observation system were adopted. It is a fact, well known to all health authorities, that the immunity question gives rise to endless discussions, and that it may be extremely difficult to decide whether an individual should be considered immune or not, according to the law, leaving for the moment entirely out of consideration the perhaps still more important circumstance that the immunity in yellow fever is not an absolute one.

Corresponding measures would have to be taken at railway stations and other points on the frontiers, though the difficulties, evidently, would be greater there than at seaports.

In places where *Stegomyia* are absent or scarce, though able to live, the only precautions necessary are those directed against introduction of mosquitos, especially infected *Stegomyia*. Passengers might be allowed to land and no subsequent observation be necessary, as a case of yellow fever would not give rise to an epidemic outbreak.

Epidemics. In the earlier history of yellow fever there are numerous examples of large outbreaks in places, as for instance New York, where *Stegomyia* cannot be present always, as they die out in winter, but thrive well when imported from elsewhere during summer. Such outbreaks are less apt to occur nowadays, with steamships instead of sailing ships, and improved hygienic conditions; but the possibility of their occurrence cannot be excluded, and it may be convenient to say a few words about the measures which would be called for in that event, and which may be applied also to epidemic outbreaks, occurring in localities properly belonging to the group of exposed places.

The chief measures in the campaign against an actual

epidemic outbreak are isolation of patients and destruction of adult infected mosquitos. The real anti-*Stegomyia* campaign, the destruction of larvae, would be too slow in its action, and can be neglected in the places with which we are here mainly concerned, as less important or even useless, since the *Stegomyia* would die out, for climatic reasons, before the effect of the campaign would have had time to show itself.

Patients should be isolated on the mere suspicion of yellow fever, and continue isolated until another diagnosis has been definitely established or, if confirmed, until the termination of the disease. Isolation takes place in patient's own house or in an isolation hospital, as previously mentioned. The latter may be arranged in a very short time, according to the same principles which have been mentioned as the leading ones for the isolation in a private house, or Marchoux's frame may be placed around beds in ordinary wards. A proper yellow fever hospital has all outside doors and windows screened and, moreover, screened doors between its various compartments, which should, to a large extent, consist of rooms for single patients.

The measures for destruction of adult mosquitos consist in fumigation of infected and adjoining houses and, when means are available, of the whole block of houses, and as many houses in infected quarters as possible.

For fumigation purposes, sulphur still occupies the first place. It has the advantages of being reliable, comparatively cheap, and easy to use everywhere, as it does not require the use of any special apparatus. Its chief and perhaps only essential inconvenience consists in the damage which it causes to many articles, especially when metals, fruits, vegetables or living plants are concerned. The danger of fire may be disregarded when proper precautions are taken. But though it be the only inconvenience, the damaging effect of sulphur dioxide forms a very grave objection to its use in many cases. It is, therefore, highly desirable to substitute for it some other substance, but so far none has been accepted as quite satisfactory.

To fumigate a house with sulphur it should be burned separately in each room, all having previously been prepared as described, covering all openings with strips of paper or cloth. The latter has the advantage of being easy to remove, whilst paper, once stuck on, often leaves ugly and lasting remnants, especially if not removed immediately afterwards. Cloth, moreover, is partially permeable, and insects which have hidden away in fissures in the walls, will therefore be likely to be killed when this material is used, whilst they might easily escape if the fissures had been covered with paper. Attention has recently been called to this point by Guiteras (1911), who recommends the use of large pieces of canvas, but it appears that the substitution of strips of cloth for those of paper, commonly used, would answer the same purpose just as well, besides being much cheaper. Sulphur is burned in the proportion of 2 lbs. to 1,000 cubic feet, or 25 grams per cubic metre. The quantity necessary, according to measurements taken of each room, is placed in a shallow basin or pan in the centre of the room; it is recommended to place the sulphur container in the centre of a larger one filled with water, on account of the danger of fire should the basin be overthrown. A special apparatus for the burning of sulphur, very simple in its construction and apparently useful, has been described by Roberts and McDermott (1911), it consists of a rack and a number of flat pans.

When all pans with sulphur have been properly distributed in the rooms, alcohol is poured over the sulphur and ignited; the disinfector immediately leaves the room and closes the door, the fissures in this last door being covered, from the outside, with strips of cloth. After two or three hours the doors may be opened and the rooms ventilated.

Pyrethrum powder, which is burned in the proportion of 3 lbs. to 1,000 cubic feet, or 37 grams per cubic metre, is frequently used instead of sulphur, when perishable goods are concerned. It does not kill the mosquitos, but stupefies them only; it is, therefore, necessary to collect all mosquitos immediately after fumigation and burn them. This is a great drawback to the method, as some insects will always be likely

to escape detection, in spite of all precautions taken, by means of paper coverings over irregular surfaces, etc. Another drawback is the comparatively high price.

Hydrocyanic acid has also been recommended as a substitute for sulphur dioxide, but it is very expensive. It is used in exceptional cases in Mérida, and is said to give satisfactory results and produce no damage. 5 c.c. of a mixture of equal parts of potassium cyanide and concentrated sulphuric acid are used for each cubic metre.

Various other substances have been recommended, as a mixture of equal parts of camphor and carbolic acid (Berry), and 'pyroform' (Francis), which are said to be effective and at the same time harmless, even to fruit, but they seem never to have been extensively used.

Carbon monoxide, which is used with excellent results as a rat-destroying agent in the Nocht-Giemsa apparatus, is said not to be a culicide. This is very unfortunate, if correct, because it would supply well-nigh the ideal disinfectant in yellow fever prophylaxis, where it is so extremely frequent that fruit and valuable goods have to be fumigated. This method has also the advantage of cheapness. It seems strange, however, that this substance should have no effect on mosquitos. In laboratory experiments I have found ordinary gas to have a very pronounced culicide action, and I propose to continue, on a larger scale, experiments with this and other mixtures containing carbon monoxide. Evidently it would be a very convenient method of disinfection if it could be done by means of gas from the central pipe system.

The whole question of fumigation is one which very much deserves further investigation.

Expeditions, etc. Lastly, we have to consider the conditions which obtain when a comparatively small number of non-immunes, generally Europeans, come to live in endemic areas for a limited period, for instance, on political, military, commercial or scientific expeditions. In these cases isolation of non-immunes, through segregation and the use of mosquito-proof habitations, are the only possible means of protection, and should be utilized to their full extent.

Segregation is practised in the way that Europeans live in a separate part of the town or quite apart from the native villages. The European quarter must be on the side of the prevailing winds; this will be the cooler situation, and mosquitos, if taken by the wind, will be carried away from, and not towards this place, from the natives' houses. No natives should be allowed to sleep in the European quarter, except a few indispensable servants, and these must all be adults. During the day, even, as few natives as possible should be admitted. This measure does not seem equitable from a humanitarian point of view, but from a hygienic one it is unavoidable.

In the segregation camp all inhabitants should sleep under mosquito curtains, properly arranged, and may use similar protection during the day, if necessary.

If these precautions are not deemed efficient, mosquito-proof houses must be constructed, all openings being screened with wire gauze, and provided with self-locking doors. The wire gauze should be of the very best kind, so that but slight attention need be paid to keeping it in order.

When leaving their houses, especially if going among the dwelling-places of the natives, Europeans must have face, neck, hands, and ankles protected. They should only walk out during daylight.

It is almost unnecessary to say that it is of the utmost importance, in the conditions at present being considered, to isolate at once all cases which may give rise to a suspicion of yellow fever. In fact, if the mosquito-proof houses are properly constructed, no other precaution will be necessary than to keep the patient inside one of the rooms where he may be nursed by his friends.

If the expedition is the beginning of a settlement, larvae destruction should be started as soon as possible.

It will have been noticed that throughout this paper the measures recommended have been such as are likely to interfere the least possible with commercial and passenger traffic. Under the conditions of modern sanitary organization, it will seldom, if ever, be necessary to have

recourse to the more severe measures as deflection of traffic and military cordons, or even, as it has been recommended sometimes, to the establishment of martial law. The result of a campaign depends on the constant watchfulness of the health authorities, always ready to take the proper measures at the first sign of danger, without allowing developments to take place which would make it indispensable to establish severe and costly measures at a later stage.

Details of sanitary organization have not been discussed in this paper.

REFERENCES

- GUIERAS, J. (1911). Una falsa alarma de fiebre amarilla. *Sanidad y Beneficencia*, VI, 5-6, pp. 656-663 (English, pp. 664-667).
- ROBERTS, N. & McDERMOTT, F. A. (1911). Report on an original form of Sulphur Burner for Disinfection. *Publ. H. Rep.*, XXVI, 13, pp. 403-410 (Abst. in *T. F. Bur. Bull.*, I, 2, pp. 91-92).
- SCHILLING, C. (1909). *Tropenhygiene*, pp. 510-513.



